MSC-07683

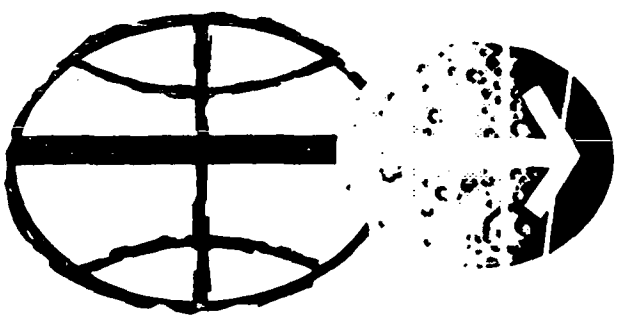
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# APOLLO 16 MISSION

# ANOMALY REPORT NO. 10

# REAR STEERING INOPERATIVE





MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
JANUARY 1973

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## Anomaly Report No. 10

## REAR STEERING INOPERATIVE

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# REAR STEERING INOPERATIVE

## STATEMENT OF ANOMALY

The Apollo 16 crew reported that the lunar roving vehicle rear steering was inoperative during the initial drive from the vehicle's deployment site to the modular equipment stowage assembly. During all subsequent driving periods, both front and rear steering operated properly. The Apollo 15 crew experienced a similar problem with the front steering.

## SYSTEM DESCRIPTION

Both the front and rear wheels of the lunar roving vehicle are steerable and are controlled by a hand controller. The driver can select front, rear, or both front and rear steering using switches located on the control and display panel. The rear steering system is powered when either circuit breaker 3 or 4 is closed, and circuit breaker 10 is closed with switch 10 positioned to the active bus (fig. 1).

When the hand controller is positioned for a right turn, the hand controller potentiometer wiper is moved toward the positive end of the resistive element. The wiper voltage will increase (become more positive) as shown in figure 2. The summing node voltage will also increase, causing the control electronics to drive the steering motor clockwise until the wiper voltage from the position feedback potentiometer is equal but opposite in polarity to the hand controller potentiometer wiper voltage. At this point, the summing node voltage will be zero (the two voltages are added at the summing node) and the steering motor will stop. A similar sequence occurs for a left turn.

## DISCUSSION

During the Apollo 15 mission when lunar roving vehicle front steering power was applied, the front steering was inoperative and the front wheels remained centered when the vehicle was turned. Later, after the front steering became operative, steering power was removed from the rear steering circuits and the rear wheels drifted off-center during vehicle turns.

During the Apollo 16 mission, when lunar roving vehicle rear steering power was applied, the rear steering was inoperative and the rear wheels remained centered when the vehicle was turned.

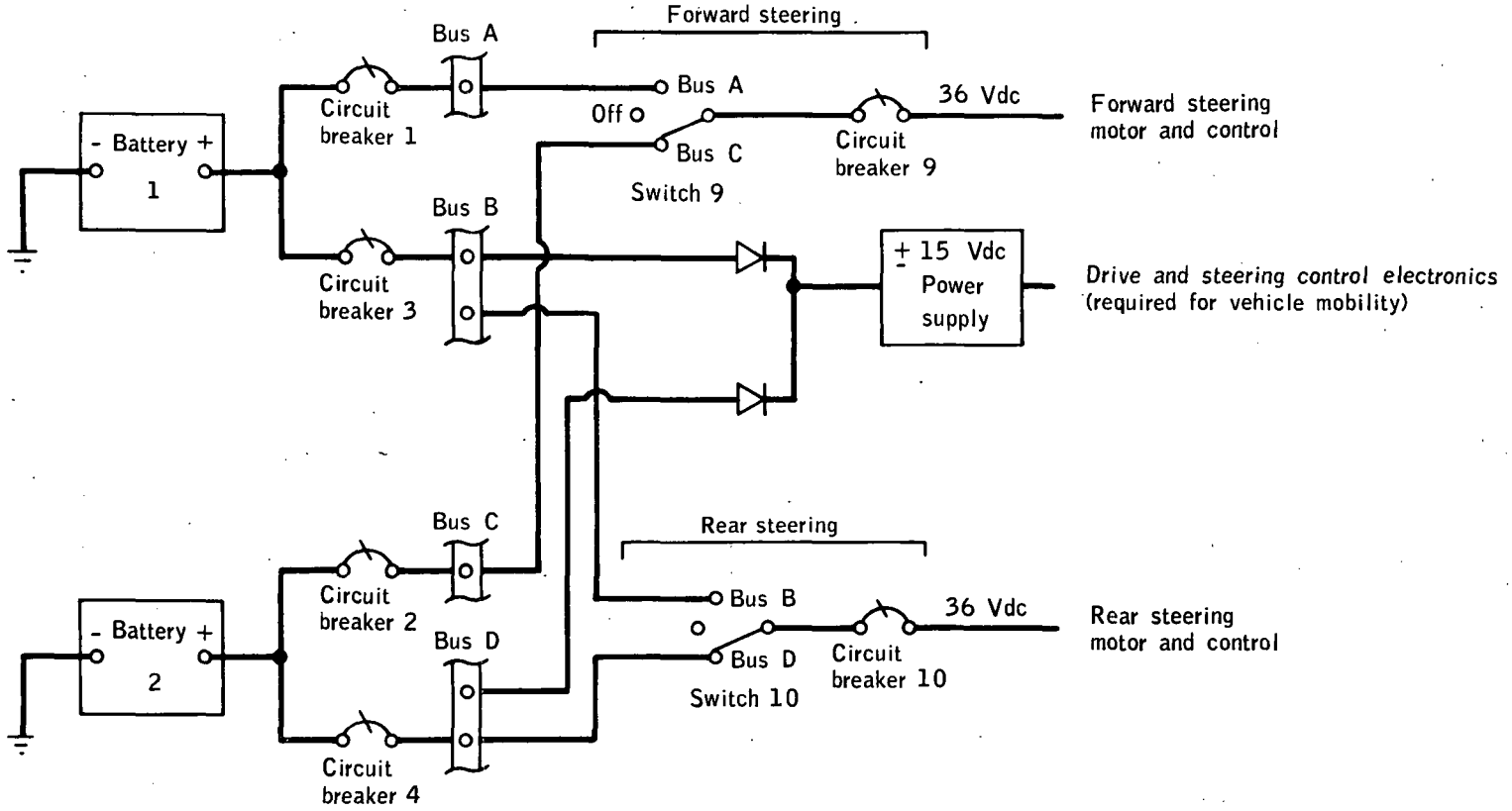


Figure 1.- Lunar roving vehicle steering power schematic.

The front and rear steering circuits of the Apollo 15 and 16 lunar roving vehicles are identical and the same type of failure probably caused both steering problems.

The only condition that will cause loss of steering and still keep the wheels centered during turns is an open circuit, either in the hand controller potentiometer or in the wiring between the potentiometer wiper and summing node (fig. 2).

The wiring, connectors, and summing resistor are all adequate. The only problem found was that the potentiometer wiper would open-circuit at temperatures below minus 58° C because the lubricant used in the potentiometer congealed. Thermal analysis, however, showed that neither lunar roving vehicle 1 or 2 reached temperatures below minus 5° C.

## CONCLUSION

An open circuit must have occurred either in the hand controller potentiometer or between the potentiometer wiper and the summing node.

## CORRECTIVE ACTION

No corrective action was taken since the problem could not be further isolated and since the vehicle design and testing were considered adequate.

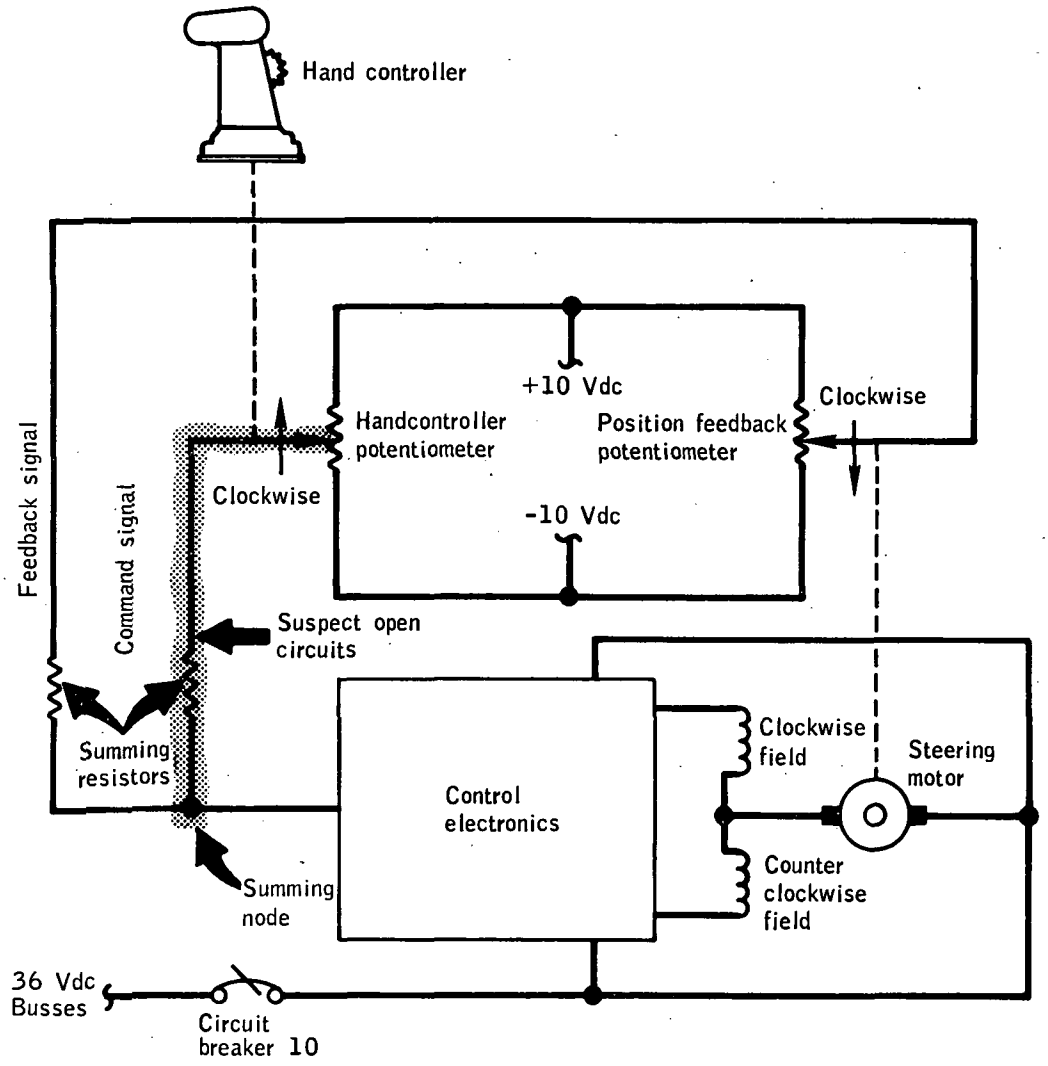


Figure 2.- Electrical steering system.